S
628.1684
W3m
1977

PLEASE RETURN

MUSSELSHELL RIVER STUDY

Preliminary Report

Prepared for Statewide 208 Project

STATE DOCUMENTS COLLECTION

JUN 14 1979

MONTANA STATE LIBRARY
930 E Lyndale Ave.
Helena, Montana 59601

Prepared By

Gordon C. Hills

Water Quality Bureau

Department of Health and Environmental Sciences

Billings, MT 59101

December, 1977

Montana State Library
3 0864 1006 8577 8

MUSSELSHELL RIVER STUDY

I BACKGROUND

A Population

B Point sources

C Main quality problems

II SAMPLING LOCATIONS

III SAMPLING PROCEDURES

IV REVIEW OF DATA

A Sediment and related

B Nutrient and related

C Conductivity and related

D Others

V SUMMARY

Digitized by the Internet Archive
in 2017 with funding from
Montana State Library

https://archive.org/details/musselshellriver1977hill

BACKGROUND

The Musselshell River basin is a sparsely populated region. Roundup and Harlowton are the two largest towns in the basin. According to the 1970 census, Roundup has a population of about 2100 and Harlowton has a population of about 1400. The next largest towns have populations of about 200-300. The total 1970 population of the basin is about 9450.

There are few point sources of pollutants in the basin. According to the Water Quality Inventory and Management Plan for the Musselshell River Basin (Basin Plan) there are 8 communities with lagoons and only 2 discharge continually with 1 discharging occasionally. There are 3 industrial facilities in the basin and only 2 have discharges. There are five agricultural permits according to the basin plan with a possibility of a few other unknown agricultural discharges.

Agriculture, rangeland and cropland, is by far the dominant land use. The main water quality problems in the basin are caused by non-point type sources which include agricultural runoff, irrigation returns and similar sources. These problems include high sediment loads, nutrient enrichment and salinity increases. Higher water temperatures, higher turbidities, and lower dissolved oxygen levels are secondary problems. All of these factors can adversely affect the aquatic biota and the use of the water.

SAMPLING LOCATIONS

A total of eleven sampling sites were selected. Both the North Fork and the South Fork of the Musselshell are sampled before their confluence. Careless Creek is sampled at its confluence with the Musselshell. The other eight sites are located on the Musselshell itself beginning at Harlowton and ending downstream near Mosby.

The North and South Forks were selected as sites in order to obtain headwaters water quality data and to use as comparisons for downstream sites. Careless Creek is sampled because it carries the outflow from Deadmans Basin Reservoir and the creek's water is generally considered to be low-quality.

The Musselshell River is sampled every fifteen to thirty miles to obtain data showing the river as it changes in water quality. The Harlowton site is on the Musselshell after the North and South Forks have joined to form the main river. The Shawmut site is located just downstream from where the Deadmans Basin Supply Canal leaves the river. The Ryegate site is just upstream from the confluence of the Musselshell and Careless Creek. The Lavina site is downstream from this confluence. The rest of the sites are separated more than the upstream sites and the data obtained from these sites show the changes in water quality as the river is affected by various small streams and canals that empty into the river. The final site is located where Highway 200 crosses the river near Mosby which is about 30 miles from where the river empties into the Fort Peck Reservoir.

Other data will be available for use in this study. This data will be obtained from the ambient monitoring program of the Water Quality Bureau and from the U.S. Geological Survey.

SAMPLING PROCEDURES

Samples are collected monthly during the winter months; that is, November through March. The rest of the year samples are collected twice a month. These samples consist of common ion, nutrient and physical parameters (Ca, Na, Mg, K, alkalinity, pH, sulfate, chloride, calculated dissolved solids, NO_2 + NO_3, total P, temperature, turbidity, conductivity and suspended solids). Samples are also collected for other parameters (total recoverable Fe, Mn, Cu, Zn, Cr and fluoride ammonia, ortho-P, dissolved oxygen, fecal coliforms)

but these samples are collected less frequently than the normal samples. In a year, these occasional samples would be collected about 8 times.

Temperatures are taken in the stream water. All other parameters were run on properly preserved samples in either the Billings or Helena Water Quality Laboratories. Samples are collected so that all time limits can be observed with the possible exception of fecal coliform samples. Instead of a time limit of six hours in the field and two hours in the lab, a total, single time limit of eight hours is attempted. The North and South Forks' samples are not run always within limits as they are at times about nine hours old when run.

Methods used for analyzing the samples are listed in Table 1.

SEDIMENTS

Increases in suspended solids (TSS) can cause several adverse effects. An increase in the amount of TSS will cause the turbidity to increase, the temperature will rise and, because of increased organic activity, the dissolved oxygen value will decrease. Since the exact TSS value depends on several factors, for example, the flow rate and currents at the sample site, the TSS value should be considered as an estimate or indicator of the actual values.

The amount of TSS in the North and South Forks is fairly low and the turbidities are low. According to this study's available data (see Table 2) there is no definite area of sharply increasing TSS values. The value increases slowly downstream until the Roundup area is reached and then the value begins to rise more quickly. The Mosby site has the highest TSS values. Previously collected data does show a great variation in TSS values. Values at the Mosby site range from 1 mg/1 to 27,000 mg/1.

Turbidities generally follow the same trend that TSS values do. The turbidities range, at Mosby, from 5 to 100 NTU's.

Values for both TSS and turbidity rise and fall from month to month and within a month can vary greatly. Available data collected during this study so far has not shown the great variation possible throughout the year. As data is collected these changes should become apparent.

NUTRIENTS

Nutrient pollution causes enrichment and leads to eutrophication. Aquatic biomass will increase raising suspended solids values, raising turbidities and deleting oxygen. Data is being collected on phosphorus, orthophosphates, nitrates and ammonia nitrogen.

This study's data shows no downstream increase in orthophosphates. During August, except for the North and South Forks and the Musselshell site near Roundup, all values are either 0.003 or 0.004 mg/1 PO_4 as P. The North and South Forks show the highest values of orthophosphates. Total phosphorus (see Table 4) does increase downstream. The first set of samples show a fairly uniform level of phosphorus until downriver from the town of Musselshell. The value nearly triples then between Musselshell and Melstone and then doubles between Melstone and Mosby. The second set of samples shows a very slightly increasing value all the way downstream. It should be noted that the South Fork is lower in phosphorus than the mainstem Musselshell while the North Fork has one of the higher values of the river.

Ammonia nitrogen (see Table 5) values remain fairly steady until the last couple of sampling sites. Nitrates and nitrites values (total as NO are hard to analyze (see Table 6). The first set of data shows a very inconsistent N level. The second set shows a fairly uniform value with only the Melstone site varying much. The Melstone value is much higher than the others.

The data relations of the North and South Forks are opposite of the phosphorus data relations. Here, for N, the South Fork value has the highest value while the North Fork has one of the lowest.

This data shows very little nutrient enrichment. The nitrogen values are below the levels required for enrichment while the total phosphorus values are borderline or lower until the river reaches the Melstone-Mosby area. Here the total phosphorus levels are well above enrichment levels. The basin plan also gives evidences of enrichment as far upstream as Harlowton. Data collected so far is so varied that no conclusions can be drawn.

SALINITY AND CONDUCTIVITY

Data shows that the Musselshell has slightly to moderately saline water and is capable of affecting adversely both crops and certain types of livestock. Many crops would be affected but with careful management crops can be grown even with downstream water. The effects on livestock would generally be slight especially with the larger animals such as cows and horses.

According to the dissolved solids data (see Table 7) the water has become slightly saline by the time it reaches Shawmut. (Dissolved solids values are over 1000 mg/l). Values tend to increase all the way downriver although the Mosby value is lower than the Melstone value. On the first sample run the Musselshell shows a definite increase after Careless Creek enters it but on the second run Careless Creek has less dissolved solids than the Musselshell has. The river becomes moderately saline around Melstone (dissolved solids values are over 3000 mg/l). As with other parameters, dissolved solids values and conductivities change - sometimes by a large amount - from the first run to the second run and average values and trends derived from this data would be nearly worthless. The data does show that there are definite problems.

SODIUM AND SULFATE

The water in the Musselshell River is generally classed as a sodium-sulfate water. This classification is derived from the major anion and cation present in the water.

The waters in the North and South Forks are classed as calcium-bicarbonate waters although in the North Fork the sulfate anion is about equal in value to the bicarbonate anion. The Musselshell at Harlowton has a calcium sulfate water with sodium values almost equal to the calcium values. Downstream from Harlowton, the water is continually in the sodium-sulfate class.

The values for sodium and sulfate become very high values in the lower end of the river (see Tables 9 and 10). The Melstone site, on August 2, 1977, has the highest values; sodium - 835 mg/l; sulfate - 2500 mg/l. The next highest values are about 50% of these maximums and this range of values occurs in most of the farthest downstream sites.

SUMMARY

The data received so far is very inconsistent. Each set of samples appears to come from a different river. Problems in water quality are obvious but not much can be done with the data yet. A full years data would be required before any real problem definition and problem solving could be attempted. The water quality data needs to be correlated with agricultural activities and weather data to set up cause and effect relationships.

TABLE 1

FOR MUSSELSHELL RIVER STUDY

Parameter	Method
Calcium	A) Edta Titration*
	B) Atomic adsorption
Magnesium	A) Edta method, by difference*
	B) Atomic adsorption
Sodium	Atomic adsorption
Potassium	Atomic adsorption
Bicarbonate	A) pH > 8.2: Titration with H_2SO_4
	B) pH < 8.2: Auto. methyl orange
Carbonate	Same as bicarbonate
Chloride	A) Auto mercuric thiocyanate
	B) Mercuric nitrate titration
Sulfate	Automated turbidimetric
Fluoride	Auto. alizarin fluorine blue method
Phosphate	Automated ascorbic acid reduction
$NO_3 + NO_2$	Automated hydrazine reduction, diazotization
Lab pH	pH meter
Temperature	Calibrated thermometer (in field)
Dissolved ions	Calculated
Lab conductivity	Wheatstone bridge
Total hardness	A) Edta titration*
	B) Calculation from Ca, Mg analysis
Total alkalinity	A) pH > 8.2 titration with H_2SO_4
	B) pH < 8.2 auto. methyl orange
S.A.R.	Calculated
Total suspended solids	Filtration
Dissolved oxygen	Modified winkler
Fecal coliform	Membrane filter
Nitrogen-ammonia	Auto. phenolate
Nitrogen-kjeldahl	Manual digest., Auto. phenolate
Total phosphorus	Persulfate digestion, auto. ascorbic acid reduction
Copper, T.R.	Atomic adsorption
Chromium, T.R.	Atomic adsorption
Iron, T.R.	Atomic adsorption
Manganese, T.R.	Atomic adsorption
Zinc, T.R.	Atomic adsorption
Turbidity	Nephelometer

* Most used method

TABLE 2

PARAMETER: SUSPENDED SOLIDS (mg/1)

DATES → / SITES ↓	8/2/77	8/17/77	9/2/77	9/15/77	9/29/77	10/12/77	10/27/77	11/10/77	12/20/77
South Fork Musselshell Martinsdale	2.8	4.5	3.7	4.6					
North Fork Musselshell Hwy 12	10.8	4.8	5.2	6.5					
Musselshell Harlowton	13.8	6.0	12.6	9.6					
Musselshell Shawmut	26.2	8.3	13.3	12.2					
Musselshell Ryegate	10.1	22.2	13.0	13.1					
Careless Creek At Mouth	18.6	26.8	19.2	11.3		ANALYSES NOT RECEIVED			
Musselshell Lavina	17.0	29.5	14.9	4.6					
Musselshell Roundup	9.8	45.4	21.2	12.0					
Musselshell Musselshell	23.8	26.4	15.6	9.8					
Musselshell Melstone	42.6	26.2	30.4	6.5					
Musselshell Mosby	74.8	--	112	100.					

TABLE 3

PARAMETER: TURBIDITY (NTU)

DATES → / SITES ↓	8/2/77	8/17/77	9/2/77	9/15/77	9/29/77	10/12/77	10/27/77	11/10/77	12/20/77
South Fork Musselshell Martinsdale	2.4	1.4	2.5	1.6					
North Fork Musselshell Hwy 12	5.2	3.0	3.5	3.2					
Musselshell Harlowton	4.0	2.5	4.1	2.9					
Musselshell Shawmut	14.0	4.5	6.9	6.2					
Musselshell Ryegate	7.1	12.0	9.2	5.2					
Careless Creek At Mouth	10.0	12.0	9.3	5.2			ANALYSES NOT RECEIVED		
Musselshell Lavina	8.5	15.0	8.8	3.0					
Musselshell Roundup	13.0	23.	14.0	6.8					
Musselshell Musselshell	13.0	13	8.2	4.4					
Musselshell Melstone	22	14	18	3.3					
Musselshell Mosby	40	--	58	53					

TABLE 4

PARAMETER: TOTAL PHOSPHOROUS (mg/l)

DATES → / SITES ↓	8/2/77	8/17/77	9/2/77	9/15/77	9/29/77	10/12/77	10/27/77	11/10/77	12/20/77
South Fork Musselshell Martinsdale	.029	.016	0.018	.024					
North Fork Musselshell Hwy 12	.050	.030	.03	.024					
Musselshell Harlowton	.031	.034	.022	.023					
Musselshell Shawmut	.052	.017	.025	.030					
Musselshell Ryegate	.020	.023	.020	.018					
Careless Creek At Mouth	.024	.027	.020	.015		ANALYSES NOT RECEIVED			
Musselshell Lavina	.037	.033	.021	.018					
Musselshell Roundup	.028	.056	.015	.022					
Musselshell Musselshell	.023	.036	.019	.021					
Musselshell Melstone	.064	.037	.030	.014					
Musselshell Mosby	.11	--	.13	--					

TABLE 5

PARAMETER: AMMONIA (mg/1 as N)

DATES → / SITES ↓	8/2/77	8/17/77	9/2/77	9/15/77	9/29/77	10/12/77	10/27/77	11/10/77	12/20/77
South Fork Musselshell Martinsdale	--	.01	.01	<.01					
North Fork Musselshell Hwy 12	--	<.01	.02	<.01					
Musselshell Harlowton	--	.01	.01	<.01					
Musselshell Shawmut	--	.01	.02	<.01					
Musselshell Ryegate	--	.01	.02	<.01					
Careless Creek At Mouth	--	.01	.02	<.01		ANALYSES NOT RECEIVED			
Musselshell Lavina	--	.01	.03	<.01					
Musselshell Roundup	--	.02	.02	<.01					
Musselshell Musselshell	--	.01	<.01	<.01					
Musselshell Melstone	--	.03	.01	.01					
Musselshell Mosby	--	--	.01						

TABLE 6

PARAMETER: $NO_3 + NO_2$ TOTAL AS N (mg/l)

SITES ↓ / DATES →	8/2/77	8/17/77	9/2/77	9/15/77	9/29/77	10/12/77	10/27/77	11/10/77	12/20/77
South Fork Musselshell Martinsdale	.26	.01	<.01	<.01					
North Fork Musselshell Hwy 12	.05	<.01	<.01	<.01					
Musselshell Harlowton	.02	.02	<.01	<.01					
Musselshell Shawmut	.03	.01	<.01	<.01					
Musselshell Ryegate	.07	.02	.01	<.01					
Careless Creek At Mouth	.05	.02	<.01	<.01		ANALYSES NOT RECEIVED			
Musselshell Lavina	.08	.02	.01	<.01					
Musselshell Roundup	.05	.02	<.01	<.01					
Musselshell Musselshell	.01	.01	<.01	<.01					
Musselshell Melstone	.23	.80	.17	.43					
Musselshell Mosby	.02	--	<.01						

TABLE 7

PARAMETER: DISSOLVED IONS (mg/l)

DATES → / SITES ↓	8/2/77	8/17/77	9/2/77	9/15/77	9/29/77	10/12/77	10/27/77	11/10/77	12/20/77
South Fork Musselshell Martinsdale	614.6	601.1	548	532					
North Fork Musselshell Hwy 12	695.8	832.5	830	798					
Musselshell Harlowton	876.5	938	929	997					
Musselshell Shawmut	1104	1186	1252	1263					
Musselshell Ryegate	1024	1051	1127	1040					
Careless Creek At Mouth	1511	1006	1210	1183		ANALYSES NOT RECEIVED			
Musselshell Lavina	1682	1132	1219	1176					
Musselshell Roundup	1859	1207	1382	1354					
Musselshell Musselshell	2005	1315	1312	1511					
Musselshell Melstone	4067	2011	1580	1678					
Musselshell Mosby	2382	--	1708	--					

TABLE 8

PARAMETER: CONDUCTIVITY (umhos)

DATES → / SITES ↓	8/2/77	8/17/77	9/2/77	9/15/77	9/29/77	10/12/77	10/27/77	11/10/77	12/20/77
South Fork Musselshell Martinsdale	694	674	638	611					
North Fork Musselshell Hwy 12	784	990	1020	943					
Musselshell Harlowton	1015	1060	1110	1228					
Musselshell Shawmut	1360	1360	1460	1447					
Musselshell Ryegate	1300	1250	1365	1280					
Careless Creek At Mouth	1780	1260	1460	1387		ANALYSES NOT RECEIVED			
Musselshell Lavina	1890	1360	1490	1377					
Musselshell Roundup	2140	1380	1600	1558					
Musselshell Musselshell	2350	1510	1490	1658					
Musselshell Melstone	4550	2400	1710	2070					
Musselshell Mosby	2600		1640	2160					

TABLE 9

PARAMETER: SODIUM (mg/l)

SITES ↓ / DATES →	8/2/77	8/17/77	9/2/77	9/15/77	9/29/77	10/12/77	10/27/77	11/10/77	12/20/77
South Fork Musselshell Martinsdale	42	44	31	31					
North Fork Musselshell Hwy 12	33	48	48	39.6					
Musselshell Harlowton	94	98	93	99					
Musselshell Shawmut	143	127	135	144					
Musselshell Ryegate	120	122	138	122					
Careless Creek At Mouth	239	132	167	161		ANALYSES NOT RECEIVED			
Musselshell Lavina	238	146	159	154					
Musselshell Roundup	285	165	208	200					
Musselshell Musselshell	325	188	196	248					
Musselshell Melstone	835	352	254	269					
Musselshell Mosby	403		289						

TABLE 10

PARAMETER: SULFATE (mg/l)

DATES → / SITES ↓	8/2/77	8/17/77	9/2/77	9/15/77	9/29/77	10/12/77	10/27/77	11/10/77	12/20/77
South Fork Musselshell Martinsdale	178	168	152	140					
North Fork Musselshell Hwy 12	204	320	320	297					
Musselshell Harlowton	344	390	378	410					
Musselshell Shawmut	440	530	568	565					
Musselshell Ryegate	484	510	560	510					
Careless Creek At Mouth	818	500	638	617		ANALYSES NOT RECEIVED			
Musselshell Lavina	807	560	615	590					
Musselshell Roundup	900	590	715	695					
Musselshell Musselshell	975	650	645	775					
Musselshell Melstone	2500	1100	850	878					
Musselshell Mosby	1400		920	1070					

TABLE 11

PARAMETER: S.A.R.

DATES → / SITES ↓	8/2/77	8/17/77	9/2/77	9/15/77	9/29/77	10/12/77	10/27/77	11/10/77	12/20/77
South Fork Musselshell Martinsdale	1.0	1.1	0.8	0.8					
North Fork Musselshell Hwy 12	0.7	1.0	1.0	0.8					
Musselshell Harlowton	2.0	2.1	2.0	2.0					
Musselshell Shawmut	3.0	2.4	2.5	2.6					
Musselshell Ryegate	2.4	2.4	2.7	2.5					
Careless Creek At Mouth	4.4	2.8	3.3	3.2		ANALYSES NOT RECEIVED			
Musselshell Lavina	4.0	2.9	3.1	3.0					
Musselshell Roundup	4.7	3.3	4.0	3.9					
Musselshell Musselshell	5.3	3.6	3.8	4.7					
Musselshell Melstone	10.8	5.9	4.7	4.7					
Musselshell Mosby	6.3	--	5.1	--					

REFERENCES:

1. Kaiser and Botz. 1976. Water Quality Inventory and Management Plan: Musselshell River Basin, Montana. Water Quality Bureau, Montana Department of Health and Environmental Sciences.

2. Water Resources Data For Montana. Water Quality Records U.S.G.S. 1963.